

WHAT IS CLAIMED IS:

1. A magnetic recording medium, in which an aluminum oxide layer having holes on a substrate is filled with a magnetic substance, comprising:

5 at least one conductive layer between the aluminum oxide layer and the substrate,

10 wherein the conductive layer has fcc structure and its (111) face is oriented in a direction perpendicular to the substrate, and the magnetic substance includes a hard magnetic substance that has hcp structure and the c-axes of which are oriented in a direction perpendicular to the substrate.

15 2. The magnetic recording medium according to claim 1, wherein the hard magnetic substance includes Co.

20 3. The magnetic recording medium according to claim 1, wherein the aluminum oxide has nanoholes formed by anodic oxidization.

4. The magnetic recording medium according to claim 1, wherein the conductive layer is a base electrode layer.

25 5. The magnetic recording medium according to claim 1, wherein the conductive layer includes Cu as a

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component.

6. The magnetic recording medium according to  
claim 1, wherein a portion of each of the fillers with  
5 which the holes are filled, the portion which contacts  
the conductive layer, has fcc structure and its (111)  
face is oriented in a direction perpendicular to the  
substrate.

10 7. The magnetic recording medium according to  
claim 6, wherein the portion touching the conductive  
layer includes Cu as a component.

15 8. The magnetic recording medium according to  
claim 6, wherein the portion touching the conductive  
layer includes NiFe as a component.

20 9. The magnetic recording medium according to  
claim 2, wherein the hard magnetic substance including  
Co includes at least one element among Cu, Cr, P, Ni,  
Pt, and Pd.

25 10. The magnetic recording medium according to  
claim 1, wherein materials from the conductive layer to  
the hard magnetic substance are given epitaxial growth.

11. The magnetic recording medium according to

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claim 1, wherein a soft magnetic substance layer is formed under the conductive layer.

12. The magnetic recording medium according to  
5 claim 1, wherein the holes are arranged in a honeycomb  
array.

13. The magnetic recording medium according to claim 1, wherein the holes are arranged in a rectangular array.

14. A magnetic record and reproduction apparatus using the magnetic recording medium according to claim 1.

15. A magnetic recording medium, in which an aluminum oxide layer having holes on a substrate is filled with a magnetic substance, comprising:

at least one conductive layer between the aluminum oxide layer and the substrate.

wherein the conductive layer has fcc structure and its (001) face is oriented in a direction perpendicular to the substrate, and the magnetic substance includes a hard magnetic substance that has  $L1_0$  structure and the c-axes of which are oriented in the direction perpendicular to the substrate.

16. The magnetic recording medium according to  
claim 15, wherein the hard magnetic substance includes  
MPt (M = Co, Fe, Ni).

5 17. The magnetic recording medium according to  
claim 15, wherein the conductive layer includes any one  
among Pt, Pd, Cu, Ir, and Rh.

10 18. The magnetic recording medium according to  
claim 15, wherein a portion of each of the fillers with  
which the holes are filled, the portion which contacts  
the conductive layer, has fcc structure and its (001)  
face is oriented in a direction perpendicular to the  
substrate.

15 19. The magnetic recording medium according to  
claim 18, wherein the portion contacting the conductive  
layer includes any one among Pt, Pd, Cu, Ir, and Rh.

20 20. The magnetic recording medium according to  
claim 16, wherein the hard magnetic substance including  
MPt (M = Co, Fe, Ni) includes at least one element  
among Cu, Cr, P, Ag, and Pd.

25 21. The magnetic recording medium according to  
claim 16, wherein materials from the conductive layer  
to the hard magnetic substance including MPt (M = Co,

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Fe, Ni) are given epitaxial growth.

22. The magnetic recording medium according to  
claim 15, wherein an MgO (001) layer is formed under  
5 the conductive layer.

23. The magnetic recording medium according to  
claim 15, wherein a soft magnetic substance layer is  
formed under the conductive layer.

10 24. The magnetic recording medium according to  
claim 15, wherein the holes are arranged in a honeycomb  
array.

15 25. The magnetic recording medium according to  
claim 15, wherein the holes are arranged in a  
rectangular array.

20 26. A magnetic record and reproduction apparatus  
using the magnetic recording medium according to claim  
15.

27. A magnetic recording medium, in which an  
aluminum oxide layer having holes on a substrate is  
filled with a magnetic substance, comprising:

25 at least one conductive layer between the aluminum  
oxide layer and the substrate, wherein the conductive  
layer has any one of  $Ll_0$ ,  $Ll_1$ , and  $Ll_2$  ordered

structures, and its square array face is oriented in a direction perpendicular to the substrate, and the magnetic substance includes a hard magnetic substance that has the  $L1_0$  structure and the c-axes of which are oriented in the direction perpendicular to the substrate.

28. The magnetic recording medium according to claim 27, wherein the hard magnetic substance includes MPt (M = Co, Fe, Ni).

29. The magnetic recording medium according to claim 28, wherein the conductive layer has any one among  $L1_0$  ordered structure including MPt (M = Co, Fe, Ni),  $L1_1$  ordered structure including CuPt, and  $L1_2$  ordered structure including CoPt<sub>3</sub>.

30. The magnetic recording medium according to claim 28, wherein the hard magnetic substance including MPt (M = Co, Fe, Ni) includes at least one element among Cu, Cr, P, Ag, and Pd.

31. The magnetic recording medium according to claim 28, wherein materials from the conductive layer to the hard magnetic substance including MPt (M = Co, Fe, Ni) are given epitaxial growth.

32. The magnetic recording medium according to  
claim 27, wherein an MgO (001) layer is formed under  
the conductive layer.

5 33. The magnetic recording medium according to  
claim 27, wherein a soft magnetic substance layer is  
formed under the conductive layer.

10 34. The magnetic recording medium according to  
claim 27, wherein the holes are arranged in a honeycomb  
array.

15 35. The magnetic recording medium according to  
claim 27, wherein the holes are arranged in a  
rectangular array.

20 36. A magnetic record and reproduction apparatus  
using the magnetic recording medium according to claim  
27.

25 37. A method of manufacturing a magnetic  
recording medium that has a film with anodic oxidized  
alumina nanoholes filled with a magnetic substance,  
comprising:

a step of preparing a substrate;  
a step of forming a conductive layer, which has  
fcc structure and its (111) face is oriented in a

direction perpendicular to the substrate, on the substrate, and forming an aluminum layer thereon;

a step of anodizing the aluminum layer and forming alumina nanoholes; and

5 a step of electrodepositing a hard magnetic substance layer, which has hcp structure containing Co in the alumina nanoholes while the c-axes are oriented in a direction perpendicular to the substrate, in the alumina nanoholes.

10 15 20 25

38. The method of manufacturing a magnetic recording medium according to claim 37, further comprising a step of electrodepositing a nonmagnetic layer, which has fcc structure including Cu and whose (111) face is oriented in a direction perpendicular to the substrate, before the step of electrodepositing the hard magnetic substance layer.

39. The method of manufacturing a magnetic recording medium according to claim 37, further comprising a step of electrodepositing a soft magnetic layer, which has fcc structure mainly including NiFe and whose (111) face is oriented in a direction perpendicular to the substrate, before the step of electrodepositing the hard magnetic substance layer.

40. A method of manufacturing a magnetic

recording medium that has a film with anodic oxidized alumina nanoholes filled with a magnetic substance, comprising:

5 a step of preparing a substrate;

a step of forming a conductive layer, which has fcc structure and whose (001) face is oriented in a direction perpendicular to the substrate, and an aluminum layer on the substrate;

10 a step of forming alumina nanoholes by anodizing the aluminum layer;

a step of electrodepositing a layer including M<sub>Pt</sub> (M = Co, Fe, Ni) in each of the alumina nanoholes; and

15 a step of formation of hard magnetic substance oriented the c-axes in a direction perpendicular to the substrate in Ll<sub>0</sub> ordered structure by annealing process.

41. A method of manufacturing a magnetic recording medium that has a film with anodic oxidized alumina nanoholes filled with a magnetic substance, comprising:

20 a step of preparing a substrate;

a step of forming a conductive layer, which has any one of Ll<sub>0</sub>, Ll<sub>1</sub>, and Ll<sub>2</sub> ordered structure, and a square lattice face of which is oriented in a direction 25 perpendicular to the substrate, and an aluminum layer on the substrate;

a step of anodizing the aluminum layer and forming

alumina nanoholes;

a step of electrodepositing a layer including MPt  
(M = Co, Fe, Ni) in each of the alumina nanoholes; and  
a step of formation of hard magnetic substance

5      oriented the c-axes in a direction perpendicular to the  
substrate in L1<sub>0</sub> ordered structure by annealing process.

42. The method of manufacturing a magnetic  
recording medium according to claim 40, further  
comprising a step of electrodepositing a nonmagnetic  
layer, which has fcc structure including any one among  
Pt, Pd, Cu, Ir, and Rh, and whose (001) face is  
oriented in a direction perpendicular to the substrate,  
before the step of electrodepositing the layer  
including MPt (M = Co, Fe, Ni) in each of the alumina  
nanoholes.

43. The method of manufacturing a magnetic  
recording medium according to claim 41, further  
comprising a step of electrodepositing a soft magnetic  
layer, which has fcc structure mainly including NiFe  
and whose (001) face is oriented in a direction  
perpendicular to the substrate, before the step of  
electrodepositing the layer including MPt (M = Co, Fe,  
25      Ni) in each of the alumina nanoholes.